Fachhochschule Hannover

Fakultät II Abt. Machinenbau

Bachelor- Arbeit

General description of Marine elevator installation process, with focus in improving door installation method

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Hannover, 19 Juni 2009

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General description of Marine elevator installation process, with focus in improving door installation method

Bachelor thesis	52 + 40 pages
Thesis supervisor	Prof. Dr.- Ing. Michael Quaβ
Commissioning company	Kone elevators Ltd, Supervisor Dipl.- Ing.(FH) Jörn Wienholz- Buβ

June 2009

Abstract

Since ships are always built in less time than before, KONE elevators must also constantly develop the installation method to shorten installation time and to improve quality. KONE Marine unit was founded in 2005, preceding processes and methods for marine business have been developed since. This development creates more revenues for the company, which is important in the tough competition situation.

This purpose for this thesis work is to create a general installation instruction and especially to improve the speed and quality of the door installation method. The general installation instruction is used to describe the differences between marine and land based elevator installations. It will be used as a base for more detailed marine elevator installation instruction. This thesis introduces the main problems related to general installation and especially to landing door installation. Another aim is to develop possible solutions to these problems.

A general installation instruction and a material flow chart were made as part of this thesis. These documents are confidential and can be found at the KONE elevators Ltd's version. The thesis also introduces solutions to the problems related to general- and landing door installation. The next step is testing the solutions in the next project, to see if they can be validated.

Fachhochschule Hannover
Kone- ja tuotantotekniikka
Tommi Heikkilä

General description of Marine elevator installation process, with focus in improving door installation method

Insinöörityö	52 sivua + 40 liitesivua
Työn ohjaaja	Prof. Dr.- Ing. Michael Quaβ
Työn teettäjä	Kone Hissit Oy, Valvoja Dipl.- Ing.(FH) Jörn Wienholz- Buβ

Kesäkuu 2009

Tiivistelmä

Koska laivanrakennus aikataulut lyhenevät jatkuvasti, myös KONE Hissit Oy:n on jatkluvasti kehitettävä hissien asennusmenetelmäänsä, jotta asennusaika lyhenisi ja laatu paranisi. KONE Marine yksikkö perustettiin 2005, ededltäviä marine businekseen liittyviä prosesseja ja menetalmiä on kehitetty siitä lähtien. Tämä kehitys tuo yhtiölle lisää voittoa kovasti kilpaillulla alalla.

Tämän työn tarkoituksena on luoda yleinen kuvaus hissiasennuksesta marine-ympäristössä ja erityisesti parantaa tasonovien asennuksen nopeutta ja laatua. Yleistä kuvausta asennusmenetalmistä käytetään kertomaan marine asennuksen erityispiirteistä verrattuna maapuolen asennusmenetelmiin. Sitä tullaan käyttämään myös pohjana yksityiskohtaista asennusohjetta luotaessa. Tämän työn tarkoitukena on esitellä isoimmat yleisseen asennus prosessiin liittyvät onglemat, sekä erityisesti tason oviin liittyvät ongelmat. Tarkoituksena on myös kehittää mahdollisia ratkaisuvaihtoehtoja näihin onglemiin.

Yleinen asennusohje ja materiaalin toimituksia käsittelevä vuokaavio luotiin osana tätä lopputyötä. Nämä luottamukselliset dokumentit löytyvät vain KONE Hissit OY:n kirjaversiosta. Lopputyö esittelee myös eniten haittaa aiheuttavat onglemat yleisessä- ja erityisesti ovien asennusmenetelmässä. Myös ratkaisuvaihtoehtoja näihin oneglmiin on löydetty. Seuraava askel on testata esitetyt muutokset seuraavassa projektissa, jotta tiedetään voidaanko esitetyt muutokset toteuttaa laajemmassa mittakaavassa.

Abbreviation list

GA	General arrangement drawing
CWT	Elevator counterweight
AMD	Elevator landing door type
OSG	Overspeed governor
BOM	Bill of material, list of parts needed for a particular elevator
HP	Stiffener type, Holland profile = bulb bar profile

Glossary

Minispace	Elevator with separate machine room
Monospace	Elevator with machinery inside the elevator shaft
Panorama	Elevator cabin with glass wall(s)
Curtain of light	Sensor which prevents the door from closing if something is between the door panels

Appendix list

Appendix 1: General description of Marine elevator installation process, 35 pages

Appendix 2: Material flow chart for installation process, 1 page

Appendix 3: Drawing of new landing door fixing method, 1 page

Appendix 4: Drawing of new landing door fixing bracket, 2 pages

Appendix 5: Updated drawing for guide rail bracket, 1 page

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1. Introduction

This thesis was done in Meyer Werft, Papenburg for KONE elevators, Marine unit. The theme for the thesis came from the need to improve the overall quality and speed of marine elevator installation at Meyer Werft, and especially the landing door installation. The installation methods vary slightly depending of the shipyard in question due to different basic construction of the trunk. The scale would have been too large in relation to the time at hand, to cover all different installation methods. Therefore this report handles only the installation method at Meyer Werft. However as a part of the thesis project a visit to STX Europe shipyard in Turku, Finland was made, to see if they have experienced similar problems.

First a description of the Marine elevator installation process had to be created. This kind of document didn’t previously exist for Marine elevators. This document helps to explain how KONE Marine elevators are installed at Meyer Werft, to the people developing and delivering the different parts. Mainly how the method differs from the installation process of land based elevators. In addition a flow chart was created in collaboration with the shipyard, to specify clearly what material is needed for the different stages of installation. The material flow chart was created also to clarify the issues and problems with logistics experienced at site. These documents can be found in the appendix section.

During the creation of the general description, several problems related to the installation were discovered. The purpose of this thesis project, in addition to creation of the general installation instruction, is to introduce them and also to try to find possible solutions to these problems. The work has been defined so that most of the thesis concentrates on the landing door installation since there can be found the biggest and most time consuming issues.

2. KONE Corporation

KONE Ltd. was founded in 1910 in Finland. The company is among the biggest in the world in elevator and escalator business. KONE has factories in the USA, Mexico, Czech Republic, Italy, the UK, Finland, China and India. KONE employs nearly 35 000 people in 50 different countries. KONE delivers approximately 60 000 elevators and escalators per year and has about 700 000 elevators and escalators in maintenance base./2/

2.1 KONE Marine products

KONE has two elevator models designed for marine use, the Minispace with conventional machine room and the Monospace, which is a machine roomless elevator. For escalators, Marine uses the ones designed for outdoor use.

All the hoisting machines represent the new gearless technology. This technology saves energy 50% compared to geared machinery. Examples of a hoisting machine for Monospace and Minispace can be seen in figures 1 & 2. The machinery weighs less than a half of the traditional geared machinery and has only one moving part, the rope pulley./4;5/

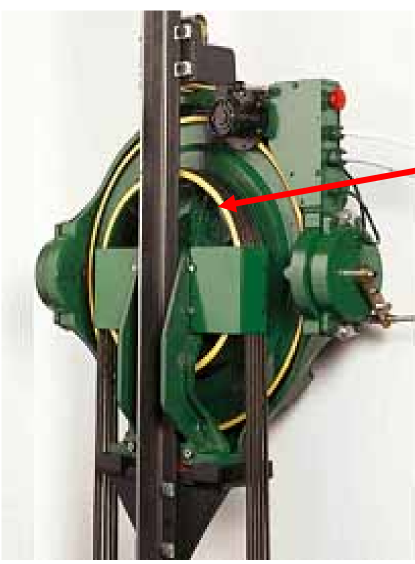

Figure 1. Hoisting machinery for Monospace./5/

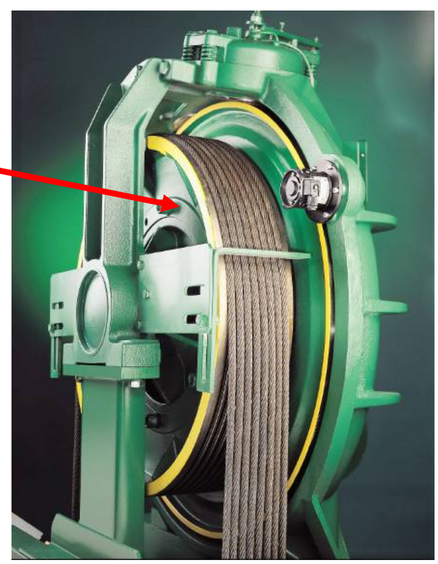

Figure 2. Hoisting machinery for Minispace./4/

Minispace elevators have a speed range from 1 to 4m/s and can transport a load of up to 1800kg, with a travel distance of 180m. The machine room can be located at the top, bottom, or at the side of the elevator shaft in the middle floors. Minispace solution can be seen in figure 3./4/

Monospace elevators have a speed range of up to 2,5m/s and can transport a load of up to 2000kg. For this elevator type no machine room is needed. All the components normally found in the machine room, including the machinery, are installed inside the elevator shaft at the last landing, as seen in figure 4. This concept saves space, which is especially important on board a ship./5/

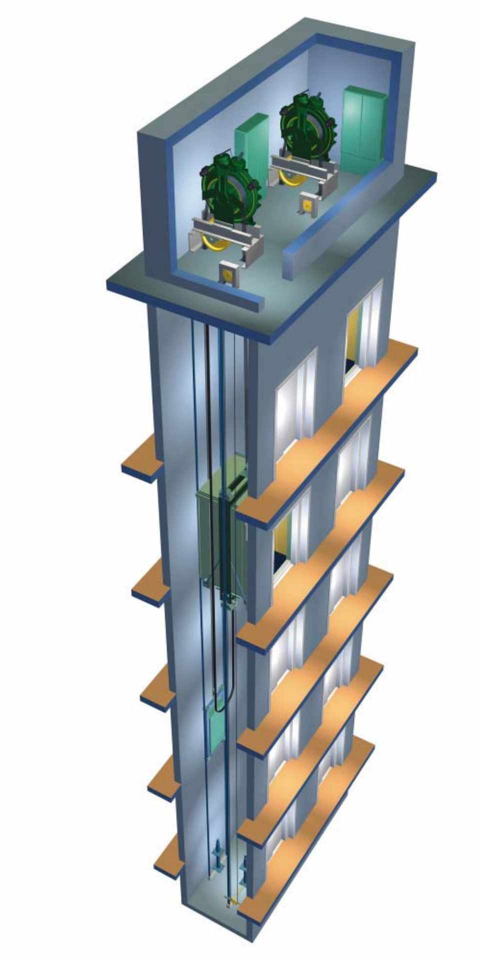

Figure 3. Principle of Minispace./4/

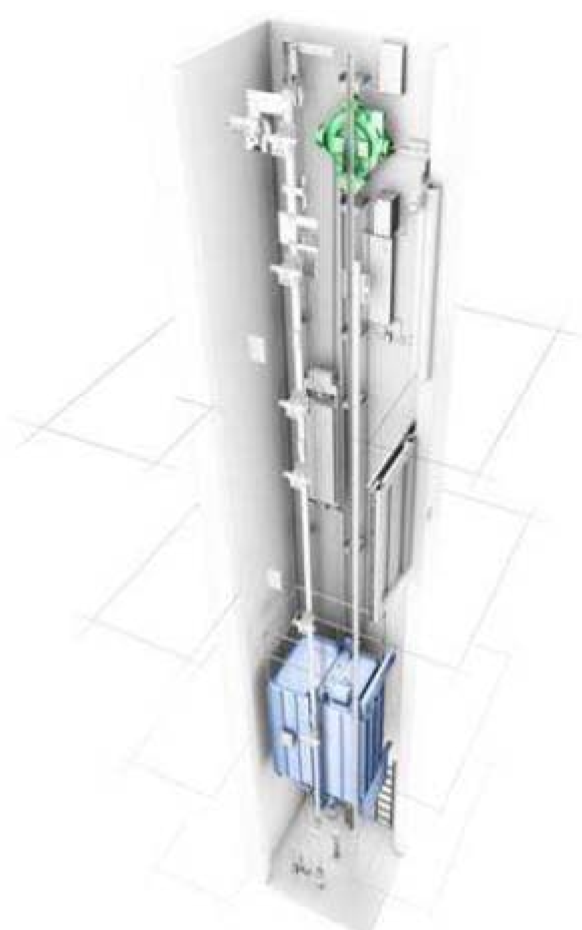

Figure 4. Principle of Monospace./5/

2.2 KONE Marine elevators Ltd.

Kone Marine unit belongs to the major projects group. It specializes in designing customized elevator and escalator solutions for cruise- and cargo ships, yacht's and offshore platforms. The unit is located at Hyvinkää, Finland. There is also a subsidiary with service personnel stationed in Miami, Florida, where most of the cruise ships equipped with KONE elevators operate. The marine unit has at the moment major projects running in Finland, France, Germany and Italy. Actual installation work is done by subcontractors, only the site managers are directly employed by KONE. Minor projects especially in Asia are often executed with the help of local KONE offices (front-line units).

A major project contains usually more than 10 elevators. A good example of a major project is the worlds largest cruise liner, the Oasis of the Seas, built in Turku. It has 44 elevators and 2 escalators. An example of a cruise ships panorama elevator can be seen in figure 5./3/

Figure 5. Panorama elevators on board Freedom of the Seas./3/

3. Meyer Werft, Papenburg

Meyer Werft was grounded in 1795, in Papenburg. It is still owned and run by the Meyer family after six generations. Originally the shipyard built wooden transport vessels for canal traffic. From there they moved on to steam powered ships. The first passenger ship built at Meyer Werft was the Triton in 1874, it was also the first ship made of steel. The first cruise ship was the Homeric, it was delivered in 1985. This ship was also the only cruise ship that was launched traditionally (sideways) as seen in figure 6. Nowadays ships are built in two dry docks (figure 7). What makes Meyer Werft special is that the dry docks are located inside massive halls. What the shipyard looks like at present can be seen in figure 8.

Figure 6. Launching of the Homeric./8/

Figure 7. Shipbuilding at present./8/

The shipyard has more than 2500 employees, making it the most important employer in the region. Nowadays they build mainly cruise ships as the Solstice (122 000 gt.) in figure 9, but also RoRo ships and LPG tankers. Ships up to 180 000 gt. can be constructed at Papenburg./8/

Figure 8. Meyer Werft at present./8/

Figure 9. Celebrity cruises Solstice./8/

4. Marine elevator installation process

The general description of marine elevator installation can be found in the appendix 1. This chapter is a short revision of the installation process. For more detailed information about the actual installation procedures, please refer to appendix 1.

The biggest problems in the installation process are described in the following chapters. This chapter gives background information which is necessary in order to understand why these particular problems cause most of the delays in marine elevator installation. The installation process itself can be divided into main parts as can be seen from chart 1. This pie-chart also shows approximately how many percentages each installation phase takes from the whole installation time. The example time calculation is from an elevator with 13 decks (traveling height 37m).

From the pie-chart can be clearly seen that the landing door installation takes 16% of the whole installation time. The main explanation for this is the high amount of doors on board large cruise ships. Therefore the time multiplies considering the whole ship, project NB676 has 233 doors, which means that altogether approximately 2300 hours are spent for door installation. This means that every minute per door saved in installation time saves a lot of time and at least money. This is the main reason why landing door installation was selected as the focus point for this thesis project.

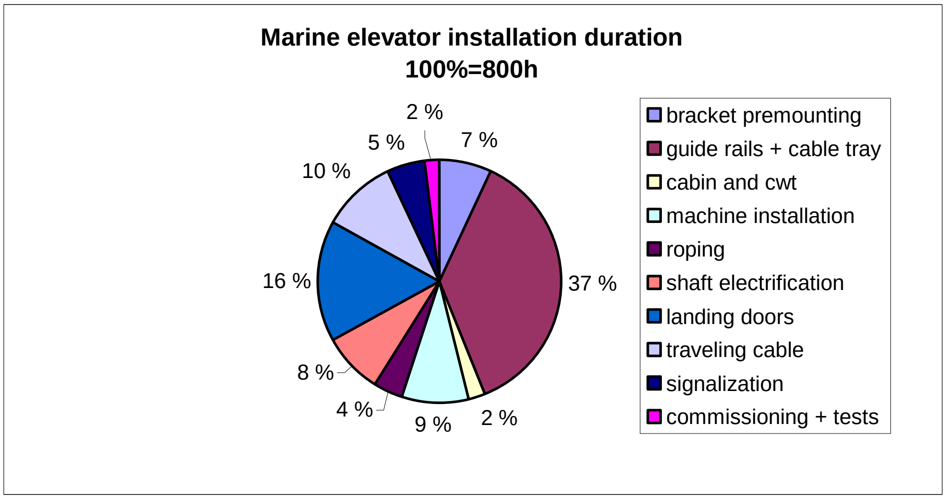

Chart 1. Marine elevator installation time distribution in percentages.

Apart from the various installation phases a major part of a ship building project is logistics. Since the project lasts over a year, it is clear that the logistics has to work. It also means that the same logistic method which is used in land based projects doesn't work. For land based elevator installations material grouping is not usually needed. Since in land based installations the elevator is built after the building, or at least the whole elevator shaft, is finished, all the needed material can be delivered together and installed during a short period of time. For ships the installation has to proceed gradually simultaneously with the actual ship building. One main difference is that in marine environment all the components have to be lifted into the ship from above with cranes. The large components such as cabin, CWT, machinery and controller can't be transported to their places by any other way. Therefore they have to be lifted into the ship when the elevator shaft or machine room is still open. This creates a problem with the logistic system, which is designed for land based installations. For more detailed description of the special logistic needs for marine elevator installation, refer to appendix 1.

As a solution the material delivery has been divided into delivery groups. These groups however are based on packages for land based elevators. This is mainly due to the fact that people are not familiar with the differences between land based installation and marine installation. The created general description, with the help of the logistical flow chart, should help also with this issue and clarify needed changes to people who are responsible for the logistics.

The one thing that complicates the installation work is that the elevator installation is not the only installation work being done in the elevator shaft. Actual shipbuilding (welding the blocks together, straightening the walls, etc.), painting and isolation are done simultaneously with the elevator installation process. Scaffolding inside the shaft is needed for this work before the elevator can be used as moving installation platform. This simultaneous work is the main reason why the scaffolding free installation method used in land based solutions would not create big advantages. Even if this system could be used for elevator installation, all the other work done inside the elevator shaft needs scaffolding. For more information about basics of shipbuilding refer to appendix 1.

5. Discovered problems in general installation process

During the creation of the General description of marine elevator installation, many problems and time consuming working methods were discovered. This chapter introduces these problems. Since the landing door installation was a focus point of this thesis, the problems related to it are introduced in a separate chapter. The solution propositions for the problems related to general installation process are introduced at the end of each subchapter.

5.1 Logistics

Many troubling issues during installation phase could be avoided by better logistics. This chapter introduces the main issues that are repeatedly done wrong. A material flow chart was created in collaboration with the shipyard to identify what material is needed for which installation phase. This chart can be found in the appendix 2.

First issue regards the delivery schedule of parts, a good example are electrification cables. They are always delivered among the first components, but since they are among the last to be installed, it creates a storage problem at the site. Since storage area at the yard is limited, the cable crates are commonly stored on top of blocks as seen in figure 10, or even worse, on the top deck of the ship. This on the other hand creates friction with the shipyard. It also creates extra work to move the crates around every other day, since they are in someone's way.

Figure 10. Electrification cable box storage on top of block

For marine installations a temporary electrification solution has been created. This makes it possible to use the elevator during installation phase without any additional electrical material. Therefore the electrical equipment is not needed before the final stages of the installation. This solution includes temporary traveling cable and main switch. The temporary electrification procedure is described in general installation instruction (see appendix 1).

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There are also other components delivered too early due to differences in flow of installation between land based and marine environments. These all together create a huge issue. Numerous examples of material delivered too early can be found. This problem has existed for a long time and storage demands a lot of space, in addition especially for electrical equipment the storage facilities at site are not suitable. To solve this issue the contents of the delivery groups must be changed and the delivery schedule adjusted to match the needs of the installation procedure. An example of the present delivery schedule can be found in the appendix of general installation instruction (appendix 1).

There are unfortunately also a lot of problems with wrong material deliveries. Especially the OSG's had been problematic during actual projects, the mistakes with delivered parts include the following: OSG's with wrong speed setting, OSG's designed for land based elevators and OSG's with wrong spinning direction. All these parts have to be replaced and this creates additional costs and even possibly delays to the project. The issue is related to BOM-process. Because marine solutions have special OSG-assemblies these are sometimes mixed with the basic land based equipment. Other frequently falsely delivered items include various parts for signalization.

Another problem is that the markings on the boxes are sometimes inadequate. For example, when a box with marking 'Shaft equipment' is delivered, there is no way to know what is inside without opening it. It can be buffers, tension weights or even signalization equipment.

To decrease the needed storage space, it has been agreed with the shipyard that there should be more communication between the two companies. The material flow chart is going to help in this process. By following it the responsible person at the shipyard knows at which point certain installation material is needed and can inform early enough the updated schedule when this operation can be carried out.

This flow chart should also help the people in KONE logistics unit to know what material is needed at certain stages of installation and they can therefore collect and send only the parts needed at that phase. In order for this to work, it requires that the material shipment grouping can be changed according to the demands of the installation process indicated in the flow chart. If this can be achieved it means that less storage space is needed at the site, which is the request of the shipyard. Since the schedules in shipbuilding are changed several times during the building period, the KONE central distribution center in Hamburg could be used as buffer storage.

The solution to reducing the mistakes in BOM process is a data input sheet. This sheet is created by the designers (mechanical and electrical) and the project manager to identify precisely what material is needed for the project. Material numbers for needed equipment such as OSG, signalization and safety gear, will be written down to the sheet. This exel-sheet will then be handed to the bommers who can identify the correct items with the help of the list. This should decrease the amount of wrong deliveries. Prototype of the list was created in collaboration with the BOM-team. It will be implemented in the next projects./18/

The markings on crates and also in KONE’s SAP-system should be better. This would help the identification of material, since with clear markings it would be easier to inform the central warehouse at the shipyard which crates are needed for the next installation phase. Now most of the crates have to be first inspected to know what they exactly contain. This would also simplify the follow up of delivered parts, since it would be exactly clear what the delivered shipment contains just by looking at the list in SAP. For clarification simplified logistical flow of parts can be seen from figure 11.

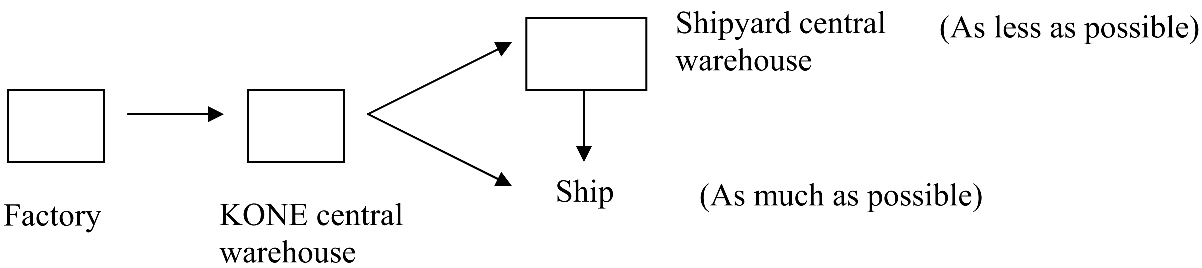

Figure 11. Logistics map.

5.2 Guide rail bracket

The main problem with guide rail brackets is that the standard M4 T-clip, which is used to fix the guide rail to the bracket, can turn by itself as can be seen in figure 12. This is a serious issue, since if the clips turn during use of elevator, the guide rail gets loose from the bracket fixing. This causes the elevator to run roughly. As a possible solution the M4 T-clip was replaced with a bigger M5 T-clip to prevent the issue with turning. This worked as the bigger head of the M5 was a better fit to the guide profile.

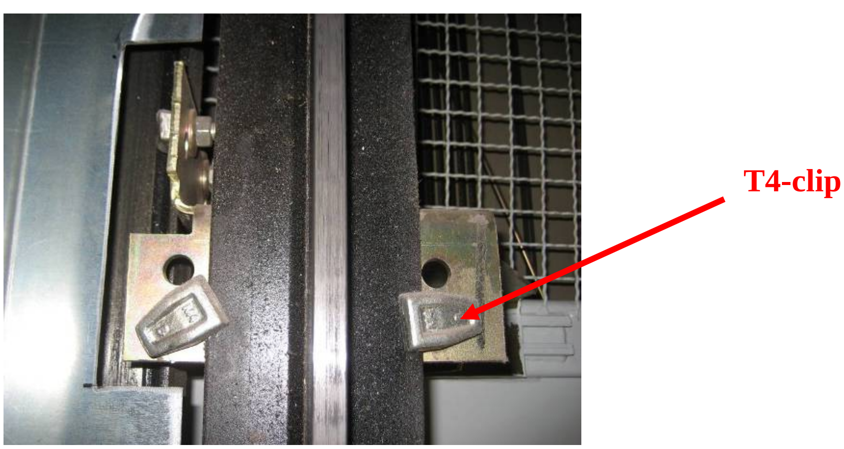

Figure 12. Example of fixing problem with guide rail.

This change caused however another problem. Since the M5 T-clip is bigger it doesn’t fit into the brackets holes. The drawing 805043 of the bracket shows the hole diameter for cabin guide rail as 18mm. This is clearly too tight. A test was carried out where the holes were drilled with M20 bore. This test resulted in perfect fit for the M5 T-clips and also proofed that the M5 T-clip functions better by not allowing the clip to turn by itself. Pictures taken before and after the test can be seen in figure 13.

Figure 13. Guide rail bracket T-clips before and after the drilling.

The result of this test requires the drawing to be changed accordingly. The hole dimension has to be changed to 20mm. The changed drawing 805043-p1 can be found in the appendix 5. Next action is to manufacture test brackets and to confirm the functionality of the new design. After the functionality has been proven, a version change to the bracket drawing must be made and the new drawing sent to production.

There is also an issue with the edges of the bracket. The bracket plates are made by punching. The edges of the bracket are not grinded and are thus quite sharp. Since the bracket can in some cases weigh over 20kg it is a clear working safety issue, it would also speed up the work if the fitters don’t need to watch out for their fingers every time they handle a bracket. Because every shaft has a bracket holding the guide rails every 1,5m from top to bottom, time saved per bracket contributes to significantly faster overall installation time. The issue about sharp edges has been forwarded to Marine unit’s Quality Manager Jyrki Nummisalo. He has reported it to the manufacturer and the next shipment of brackets will be controlled at the site, are the requested changes implemented or not.

5.3 Panorama elevator cabin doors

Since the Panorama cabin doors are not installed at the factory, because of risk of damages during transportation, they have to be installed locally at the site. First issue with the installation is that the nuts holding the glass panel at place (figure 14), are located at the cabin side.

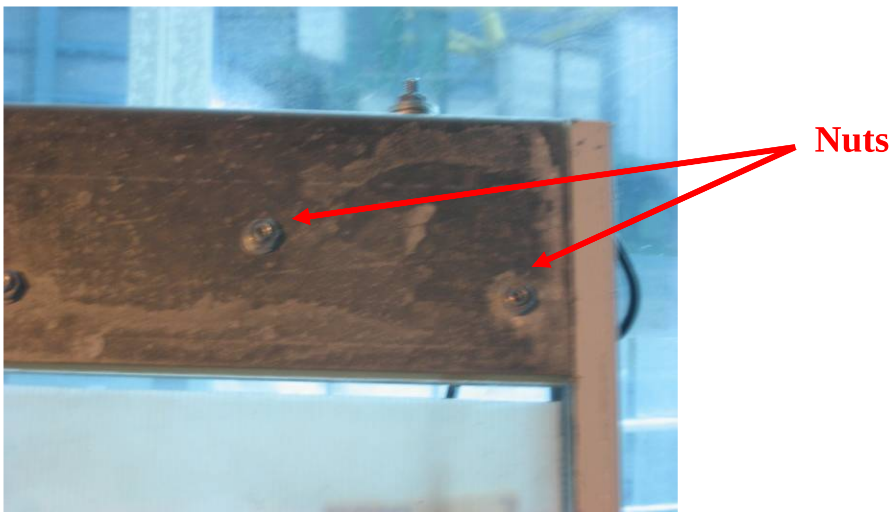

Figure 14. Nuts located at the cabin side of the cabin door.

This creates a problem with the door frame since the nuts prevent the door from opening and closing properly, by hitting to the cabin door frame. Therefore the fitter has to cut a hole to the frame in order to make the door work. This procedure can be seen in figure 15.

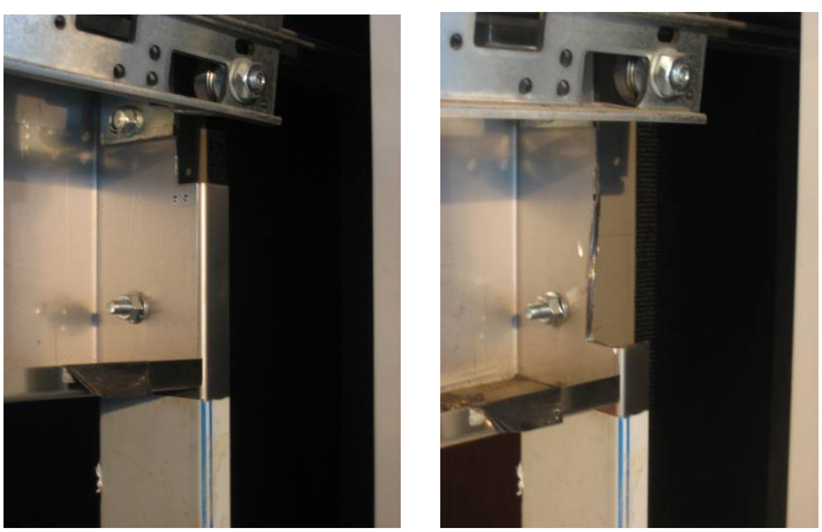

Figure 15. Cabin door frame before and after cutting.

The next issue regarding these cabin doors is about the fixing of door panels to the railing. This is done after the door is slid into the sill groove, by fastening the pin seen in figure 16 going thru both the frame and the door panel.

Figure 16. Door panel fixing pin.

Figure 17. Poor hole alignment.

There is however an issue with the quality of the parts. Usually the peaces don’t match, resulting in difficulties during installation. An example, where the holes of the two components are not correctly aligned, can be seen in figure 17. The height of the door panels can also vary. This causes problems when the door is fitted between the sill and railing. If this happens the railing height has to be adjusted before the door fits.

The final issue is that the curtain of light is installed at site by fixing it directly onto the door. The reason for this decision is that the original fixing brackets for the curtain of light are too weak. There is a chance that because of the vibrations experienced in a ship the sensors will vibrate too much and therefore will not work properly creating a safety issue. This is the root cause why this operation is done at the site. This is however a very time consuming task. It takes a fitter 25 minutes to install one list. Therefore in this project (NB676) with 8 panorama elevators it took altogether 4 hours just to install these lists. The work itself is quite simple. It includes drilling holes to the frame for the fixing screws, fastening the list with the screws and fixing the sensor and the electric wire. This could easily be done already in the factory where the actual cabin door were manufactured, thus saving precious time at the site./15/

To solve the issues with cabin door, the glass panel fixing style has to be changed. Easy way to do this is to change the nuts to the other side of the door. This way they are not in the way. This issue has to be however finally decided at the cabin factory in Hyvinkää. The fixing brackets for curtain of light should also be redesigned so that they are not so vulnerable to vibrations. The issue of differences in door height and compatibility of door parts is an issue for quality control. Issue with glass door nuts has been forwarded to Marine unit Quality Manager Jyrki Nummisalo and will be discussed at the next quality meeting (QIT).

5.4 Electrical parts

Electric parts have considerable failure rate and numerous different parts must be replaced during installation in order to achieve functionality. This is mainly due to the issues related to logistics. Many electrical parts are delivered to the site at early stages of the installation. This means that the electric boards and wires are stored at the site sometimes over half a year. During this time they are exposed to various weather conditions which they are not designed to withstand. Therefore it is not a surprise to notice that they don’t work anymore when the commissioning of the elevator has started.

Another problem caused by the long waiting period is that, since the boards are manufactured at least a year before installation and the controllers one and a half year before, but the software for the elevators is always the newest, there are many compatibility problems during commissioning. Especially the new software versions create difficulties, since the old board doesn’t work together with it. This leads to a lot of time used for failure searching.

A good example regarding time saving are the extra loud speakers. These are needed for every landing of every passenger elevator because the speaker inside the standard signalization assemblies is not loud enough. Although this component is a special solution, the delivery is not reasonable. The speaker assembly is delivered in parts. Speaker, front plate, back box and parts for fastening are packed and delivered separately, as can be seen in figure 18. First the parts have to be unwrapped, especially the speaker part has been wrapped with enthusiasm.

Figure 18. Parts for speaker assembly.

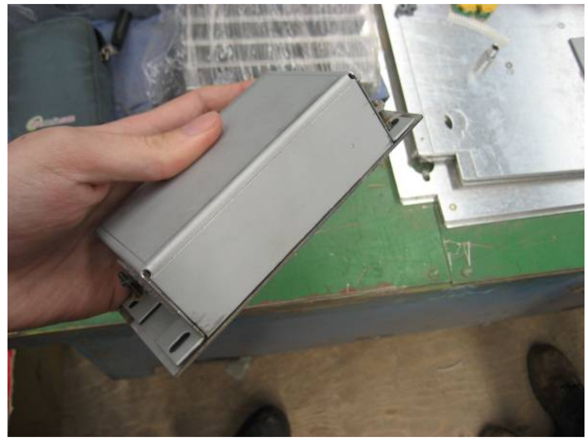

Figure 19. Assembled speaker box.

The actual assembly of the speaker system takes about 4 minutes, including all assembly of the nuts and other small parts needed to hold the components together. This work for all the passenger elevators in the ship (project NB676 has 12 passenger elevators with 131 floors) however takes one man two working days. Since the assembly itself is quite simple as can be seen form figure 19 and involves only putting the different parts together, it should be possible to assemble the parts already at the factory where the parts are fabricated. It should be possible to assemble the components at least twice as fast in the factory conditions, thus saving time and valuable resources at the site./14/

The issue has been informed to the purchase department and they are looking into it, if they can find a supplier who can manufacture and assemble the components before sending them to the site. The price is of course the determining factor. If it is more expensive to assemble the parts at the factory, compared to the value of the work put into assembling them on board, it is hard to convince the purchase department to change the deliverer.

6. Landing door installation process

Landing door installation was chosen as the focus point for this thesis, since if the problems related to it can be solved the installation time will be shorter and the costs for the whole installation will go down. As explained in chapter 4, the landing door installation is with the guide rail installation, one of the most time consuming phases in marine installation process. Installing the AMD-landing doors on board differs from land based elevators in many ways. This creates problems since the product was developed mainly for land based use. An installation instruction for the marine landing door exists, but it was made 10 years ago and doesn't comply with present day procedure.

6.1 Marine landing door installation

For more detailed description of the marine landing door installation method refer to appendix 1. The aim of this chapter is to give a brief introduction to the landing door installation process. A typical marine door installation on board a cruise ship consists of 200- 300 doors. For door installation must be then reserved 2000-3000 hours.

The installation can be divided into 6 phases. These phases and the approximate amount of time in percentages used for each phase can be seen in chart 2. For the chart is again used, as an example case, an elevator with 13 decks (traveling height 37m).

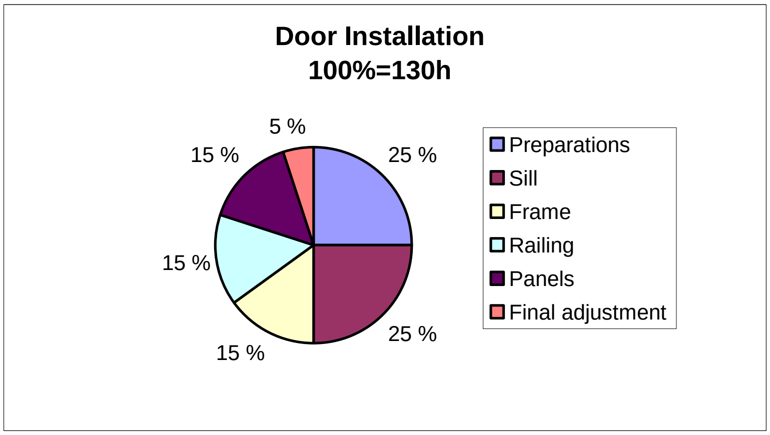

Chart 2. Duration of door installation phases in percentages.

From the chart can be seen that the preparations and door sill installation take already half of the whole installation time. This shows clearly where time in installation process can most likely be saved. The preparation phase consists of all the measuring needed in order to get the doors in the shaft aligned horizontally and vertically. It also includes the pre-mounting of the door sill parts. All the different door installation phases are done for every door in the shaft at the same time, for example all the sills are installed first, then the door frames and so on.

The sill installation phase begins by welding the pre-mounted C-profile fixings to the shaft wall. The vertical and horizontal position of the fixings has been measured as part of the preparations. After the C-profile and bolt assembly is installed the actual sill profile can be installed. When the distances for the sill have been adjusted and checked, the assembly is fixed by welding additional supports.

In the frame phase, the up rights and the top part are installed. First the up rights are fixed to the door sill and then the top part to the uprights. At last the assembly is fastened by welding it to the trunk wall, using the fixings located at the side of the top part.

Railing is then fixed onto the frame top part with screws. To secure the railing fixing it is welded directly to the trunk wall with the help of support fixings. In case of wider than 1000mm doors the railing has to be welded also at the middle for better support.

The door panels are installed last. Panels are fixed to the railing with screws. This phase requires mainly adjustment work, in order to get the doors to function the way they are supposed to. During the last final adjustment phase, the door functions are optimized. This includes installing door counterweights.

6.2 Differences between land based and marine AMD-solutions

First it is important to understand the main differences between land based elevator landing door installation and marine landing door installation. This chapter gives background information about why the installation is done the way it is and the differences compared to land based elevators. This background information is needed to understand the restrictions for introduced solutions. The problems are described in chapter 7. The solution suggestions are presented in chapter 8.

As already explained in chapter 4 the logistics are completely different. This is the main reason why the ready assembled landing door used in land based installations is not the best alternative in marine environment. First issue with the ready assembly is that it can not be easily transported to the elevator shaft when the actual door installation phase begins, due to lack of space. Therefore it would have to be lifted into the ship during block building phase. This would create a problem with storage. The only reasonable option would be to store the landing door assemblies inside the shaft. This is not however a practical solution since there are many different construction phases going on inside the shaft before the door installation can begin, for example parts of the scaffolding in shaft are built and dismounted at least three times during the whole installation (because of welding, painting, isolation and other work done by the shipyard). A fully assembled landing door, similar to used in land based installations, can be seen in figure 20.

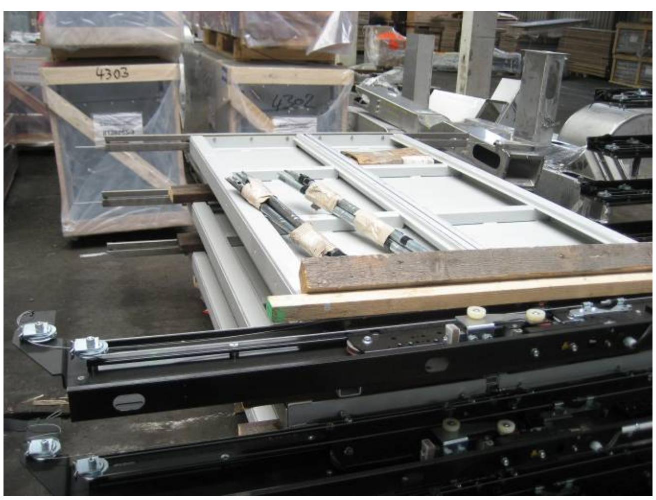

Figure 20. Fully assembled landing door.

The differences in logistical flow have led to the decision to build the landing door assembly at site. This way the different parts can easily be transported to the elevator shaft even when the shaft is closed. This solution also gives better possibilities to adjust the door position, for example in case needed because of the shaft straightness. This method is also altogether faster to install if the preparation phase measurements are done correctly.

In land based elevators the door fixings are done by using anchors. The bracket is mostly bolted directly to the concrete wall of the shaft with anchors and therefore the fixing brackets for railing and door sill are designed slightly different. In marine environment all fixings to shaft wall have to be made by welding.

One of the biggest differences is in how the positions of different components can be measured. In marine environment conventional plumb lines can not be used, since the ship can be inclined during construction. This creates problems in installation, which are solved by using templates as much as possible. This way after the cabin is aligned, as explained in general installation instruction, all door sills can be aligned by using the cabin’s position as a measuring template. This ensures that they all stand at the same position in relation to the cabin door./6;7/

7. Problems in landing door installation process

This chapter introduces the found problems in door installation process. The solutions for these problems are introduced in chapter 8.

7.1 Logistics

The parts for landing door assembly are delivered in disorganized way. Now it is done so, that door sills, up rights and top parts are all in the same crate, as can be seen in figure 21. This means that before door frame installation can begin the parts have to be sorted, since only the door sills are needed at the first stage, up rights at the second and so on. It adds time to the door installation preparation phase (chart 2). This could be done much easier and therefore save time. /13/

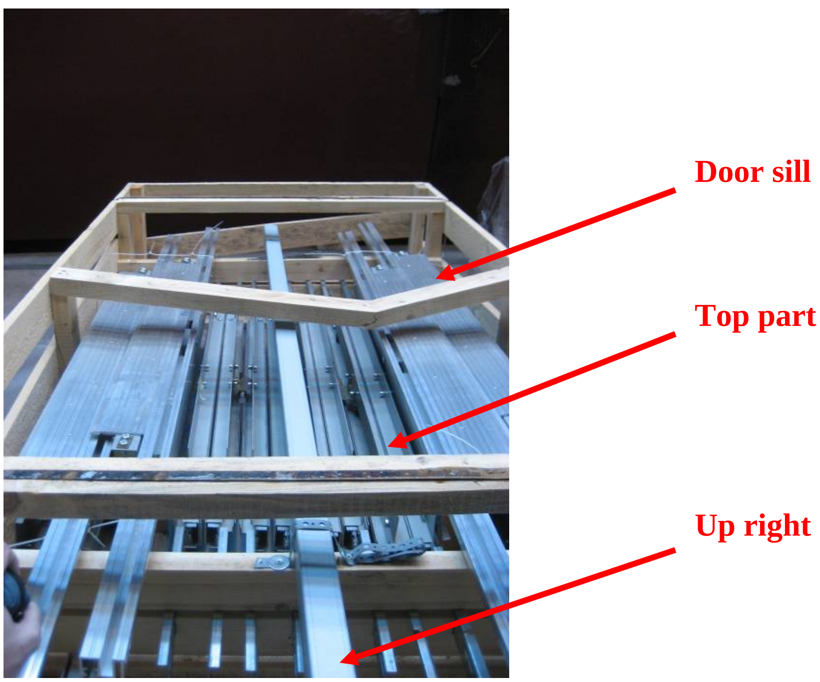

Figure 21. Door frame parts delivery crate.

Since the locally developed fast fixing method differs from the one in the installation instruction for marine AMD-door, a lot of unneeded material is delivered to site. For example the crate containing fixing material for landing doors, contains 24 different items. From these items only 8 are used. All the other parts were thrown away. Examples of material thrown away can be seen in figures 22&23. This must incur unnecessary expenses for the company, since it happens with every elevator. Among the parts thrown away are the nut and washer packages for upper fixings. This result in double loss since they are all packed into plastic, therefore also the value of the work put into packing these items is lost./6;13/

Figure 22. Useless fixing material for landing door railing.

Figure 23. Useless fixing material for landing door frame.

7.2 Door Fixings

The current installation manual (AM-03.12.042-MAR) instructs to fix the AMD doors railing and door sill with bolt fixings to a C-profile. In reality only the door sill is fixed this way as seen in figure 24. The frame top part is only fixed at the sides, using side supports which are welded directly onto the trunk wall, fixing extensions are not used, as seen in figure 24. In addition the railing is welded to the trunk wall with flat irons, not with the original fixing plate (also in figure 25).

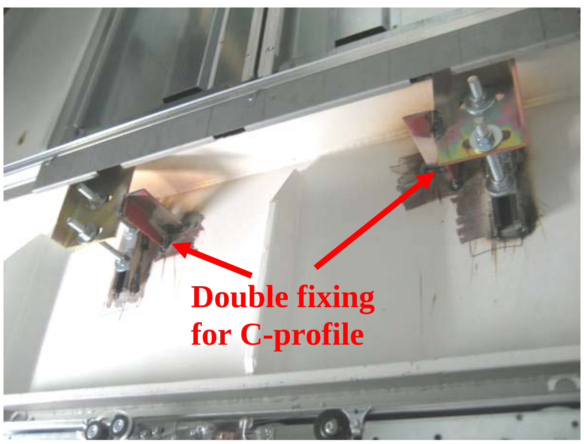

Figure 24. Door sill C-profile fixing.

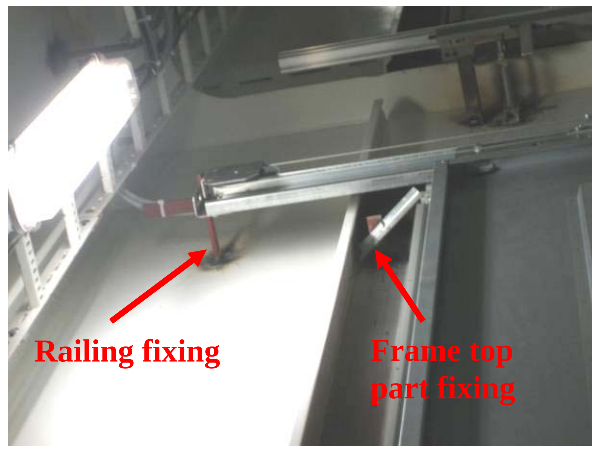

Figure 25. Top part and railing fixing.

These alterations mean that a lot of unneeded fixing material is delivered for each door, the material is introduced in chapter 7.1. This fixing method has been in use for past 7 years without complaints, so the systems functionality can be seen as proved. The original system would reguire even more welding work done for all fixings. This old method was also much slower to install because of too many different fixing types (brackets and plates). The main issue with the used fixing method however is that, with so much welding (even now) done onto the trunk wall after the shipyard has painted the trunk, both from the inside and outside, the painting has to be done for the second time. The welding marks, shown in figures 24 and 25, have burnt the paint surface from both sides of the trunk. This creates huge amounts of extra work and cost for the yard, or for KONE depending on contract.

The bolts used in the C-profile fixing are problematic. All bolts and nuts are delivered separately, packed individually in plastic. This means that before the actual sill installation work can begin the fitter has to preassemble the bolts and nuts. Also the C-profiles were temporarily Zink coated, this created hazardous welding fumes in installation. The pre-fabrication is time consuming task. For example to spin the nuts in place for one 300mm bolt takes about 4 minutes. When an elevator has for example 13 levels and each level requires 4 of these bolts, it takes roughly half a day just to prepare the sill installation. This explains part of the high amount (25%) of time used to pre-fabrication. The different steps from delivered to prefabricated C-profile fixings can be seen in figures 26 and 27.

Figure 26. Delivered sill fixing parts.

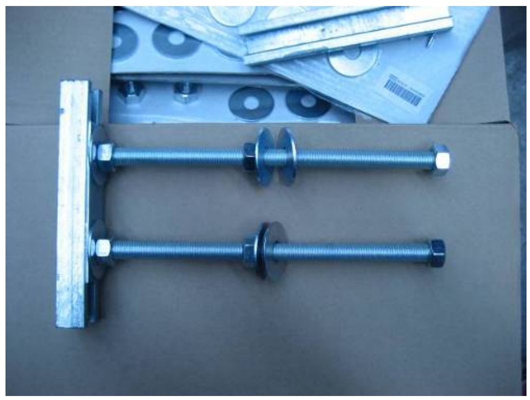

Figure 27. Pre-fabricated sill fixing.

The bolts delivered are 300mm long while the sill distances vary normally between 180 and 220mm. This means that the bolts also need to be cut shorter after installation. The only other alternative bolt length at the moment for center opening AMD-door, according to drawing 845794, is 130mm, which is too short. The fully pre-fabricated sill assembly can be seen in figure 28.

Figure 28. Pre-fabricated sill assembly.

Generally using only bolt joints in ship environment is not the safest method. Since the ship is constantly vibrating, bolt-nut combination can become loose thru time and it is therefore common to fasten the fixing plates by additional spot welding. It is also simpler and faster, since other welding work has to be done anyway during frame installation. For example the sill is also welded to the trunk wall in addition to the bolt fixing as seen in figure 24. This fixing is designed to stabilize the sill assembly. The bolts are used for fine tuning the sill distance from the shaft wall. The new solution should also allow this kind of ‘double’ fixing without burning outside wall when welded.

7.3 Landing door top part

A problem occurs constantly with the top part. The door emergency opening device mechanism doesn’t work. The problem is caused by one of two possibilities. The first is that the return spring of the lock is completely missing, second alternative is that it is installed the wrong way, this case is shown in figure 29. This is easy to spot since the ‘handle’ points in the wrong direction.

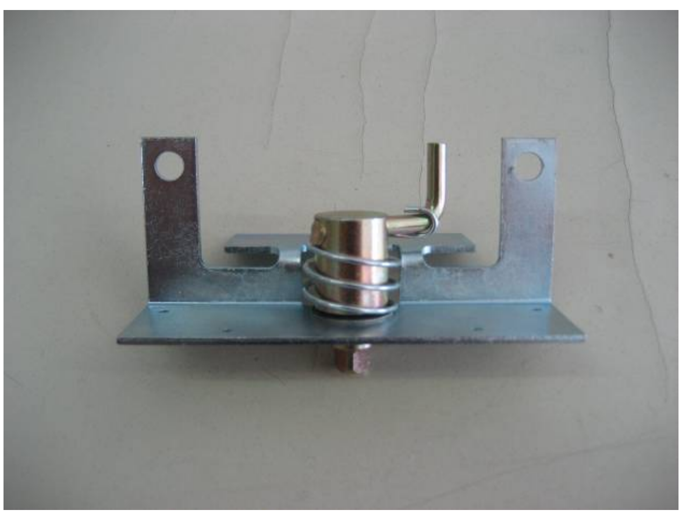

Figure 29. Falsely installed return spring.

Both of these lead to the same end result, the doors can't be opened correctly manually from the outside. This is a safety issue and therefore the locking mechanism has to be disassembled and checked for every door before commissioning. In installation phase it hinders the work, since most of the doors don't open from the outside before corrective actions are done. The landing doors are installed as soon as possible to prevent the possibility of people falling into the shaft thru door openings. Therefore the opening device is already needed during the installation to open the landing doors, when doing rest of installation work inside the shaft.

In the drawing for the emergency door opening device, drawing number 731435G02, the spring position is displayed falsely. This could be the ground reason for the spring being installed the wrong way. It doesn't however explain the cases where the spring is completely missing.

A temporary solution for correctly fastened return spring can be seen in figure 30. As can be seen, to achieve functionality the spring has to be fastened so that it actually returns the lever, instead of just spinning around. This is the case if the spring is left in the condition as it is delivered.

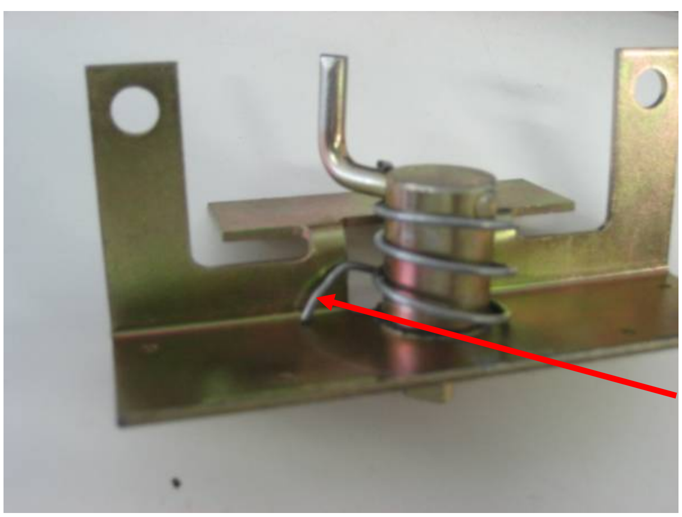

Figure 30. Correctly installed return spring.

7.4 Material quality

Material quality has become a serious issue after the door production was transferred to new factory in Usti nad Labem, Czech Republic. Quality has improved gradually, but there are still some unsolved problems.

The landing door frames up rights are a good example of the material problems. In this project (NB676) the measured material thickness of the up rights has varied from 1,8mm to 2mm. The drawing for this part specifies the thickness as 2mm. This creates a problem with stability, since even the 2mm thick up rights are a bit unstable. The stability problem has been also noted at the STX shipyard in Turku. /11/

The material thickness of the up right has been reduced twice, according to drawing alteration history (drawing 731007). This has probably been done to save in material costs, but it is not the best alternative for part used in marine environment. The edges of the up right are nowadays also a cause of concern. Since these edges are not rounded after bending process, it is a serious working safety issue. Usually if the frames are handled without gloves there is a high risk of deep cuts and scrapes. Sometimes the weakness of the material causes a problem with the screw fixings of up right and top part or door sill. The screws don’t bite to the material and can not therefore hold the assembly together. If the screws won’t hold the assembly in place a welding joint has to be added as seen in figure 31. This is off course extra work and it shouldn’t be necessary if the parts are produced with the correct quality./16/

Figure 31. Example of a welded frame up right fixing.

The landing door panels are also a notable problem, especially the decorative door panels. At latest new buildings e.g in Solstice (project NB675) the quality of delivered panels has been a problem. An example can be seen in figure 32 from NB676, where the panels are bent both vertically and horizontally. This kind of doors can not be used, since it will not open properly.

Figure 32. Bent decorative door panels.

Other issue with door panels is, that the panel is sometimes delivered twisted. Since this issue occurs with normal door panels it can be fixed by forcing the panel straight. This is done by twisting the panel by hand after it is fixed to the railing and door sill. This method however creates another problem. If the spot welding of the door counterweight shaft is not done correctly it breaks due to the existing tension in the panel, if the panel is forced straight.

There are also issues with the landing door panel counterweights. The door counterweights purpose is to close the door if it is opened manually and in case the ship is inclined to help the door to close. One issue is that the wire which holds the counterweight sometimes snaps. This issue has happened also at other yards like STX Europe in Turku. Another issue with the counterweight wire is that the wire is not properly attached to the weight.

The problem lies with the clamping of the wire. From figure 32 can be seen the old way of clamping the wire and the present way, which has resulted in broken connection. As can be seen from figure 33, in the broken assembly the clamp at the end of the rope is very short and the compression mark is too shallow. These issues create a problem where the weight can drop into the bottom of the counterweight shaft or in the worst case with A-60 doors to the bottom of the elevator shaft. For information about door counterweight shaft locations and function refer to appendix 1.

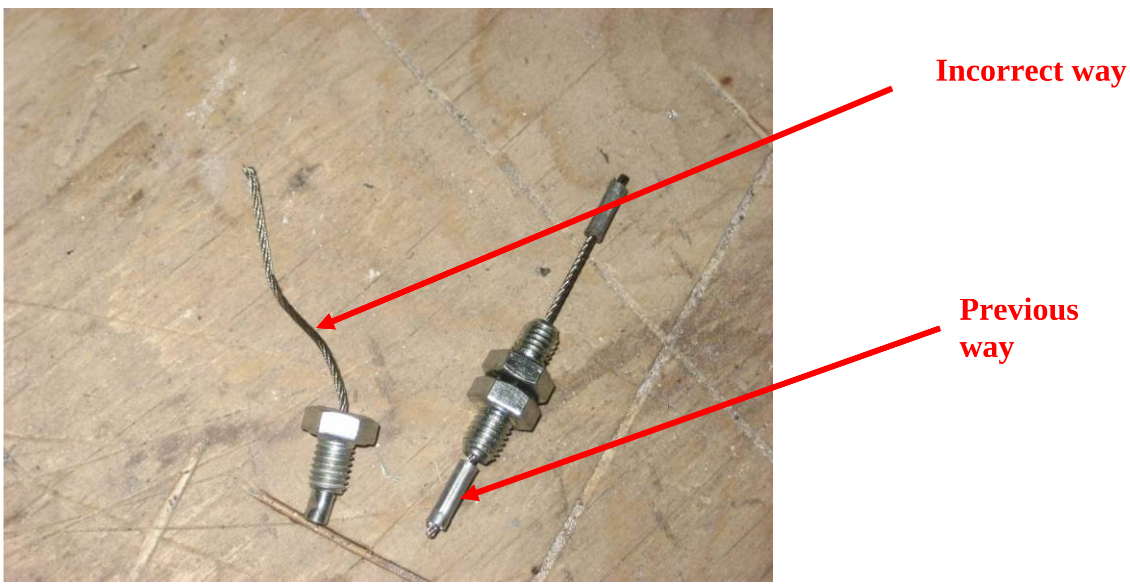

Figure 33. Landing door panel counterweight wires.

The poor quality of the wire and the wire connection of the door counterweight are a serious problem considering door use. If the wire counterweight assembly breaks during use the door will not close properly in rough weather conditions, resulting in disturbance announcement. This is also a safety issue, if the landing doors remain open after manually opened, someone can fall down the shaft. Fixing these problems at site costs again precious time and resources.

8. Solutions to problems in landing door installation

This chapter introduces possible solutions to the installation problems and material issues regarding landing doors. Compared to the competitors landing door installation method, which is done by installing the whole frame as one piece, similarly as in KONE's land based installations , KONE's method of assembling the parts at site is faster to install and easier to adjust in marine environment. Since the landing door assembly is in parts, all the fixings can easily be adjusted individually according to measurements already in the installation phase.

Therefore the actual method itself has no major fault. It doesn't include a storing phase inside the ship/block, if the logistics run according to plan. The major improvements can be found in the amount of work and time needed for landing door installation and in quality of parts, so that the work doesn't have to be made twice. By speeding up the pre-fabrication phase and removing the repair work (repainting of door wall, replacing broken parts), a lot of time and money can be saved (for both KONE and the shipyard).

8.1 Logistics

The delivery crates for door frame parts could be reorganized so, that first crate would contain up rights, second door sill assemblies and the third top parts, per elevator. The railings are already delivered in separate crate but this crate could also contain the new fixing brackets. This way there would be no need to sort out the parts before installation. Each crate should also contain only the needed fixings for the parts it contains, packed into boxes (one box per door). This suggestion has been forwarded to Usti door factory. They are looking into it. For clarification the delivery of door parts should always be according the following pattern:

1. crate DOOR SILLS
2. crate UP RIGHTS
3. crate FRAME TOP PARTS
4. crate RAILINGS
5. crate DOOR PANELS

This way the site personnel will always know which parts need to be picked up to ship.

The amount of unnecessary material could be less, if the organization responsible of collecting the various parts of the landing door assembly would create an own material code for marine door assembly. Under this assembly would be gathered only the parts that are needed in the actual assembly. This would enable to pack the fixing parts into the same delivery crates with the frame parts, thus at least one crate less per elevator would have to be delivered.

Some issues with logistics are still open. The suggestion of using the KONE delivery centre in Hamburg as a temporary intermediate storage will be tested for project NB687. Also the material delivery group changes, the new material groups seen in the flow chart (appendix 2), will be implemented for NB687. The changes to improve package markings in crates and in SAP-system have not yet been implemented by the supply chain.

8.2 Fixings

The main improvements in the landing door installation method can be achieved by improving the fixing method. The improvements regarding stiffener positions and other things belonging to yard scope of delivery have been discussed with engineers from the shipyard. Because the alterations can only be tested in the next project (NB687), where the shipyard has slightly different stiffener design than in previous projects (including the presently built NB676 and 677), there was a good chance to have an influence also to the design of trunks. As the frame up rights are only fixed to the door sill and to frame top part with screws, with no connection to the trunk walls this chapter introduces solutions for lower and upper fixings (frame top part + railing). Figure 34 is for clarification purposes. When a trunk wall is discussed in the next chapters regarding the fixings, the wall in question is referred to by the letters shown in the drawing.

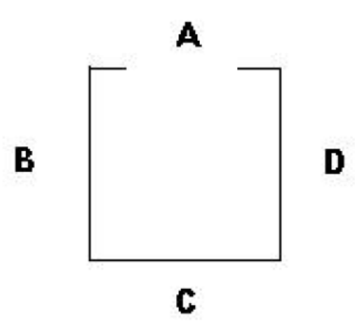

Figure 34. Trunk wall references.

8.2.1 Lower fixings

A solution for the problems regarding lower fixings was created for project NB687. The design of floor support between the door openings has been changed for this project by the yard. In the new design the vertical stiffeners located between the door openings (A, figure 34) for service elevators, don’t exist. The trunk is supported between the door openings by the decks floor structure. Therefore the original idea of replacing the trunk stiffeners, between the door openings, with U- or L- profiles wasn’t applicable for all elevators. This would have reduced the weight, since for the shipyard it doesn’t matter is the stiffener shaped as bulb bar profile or some other profile for so short distances./12/

Since the stiffeners in service elevators trunk don’t exist, the only possibility is to add something. U- and L-profiles are both suitable and easily acquirable, they both have their own advantages and disadvantages. For passenger elevators the stiffeners can possibly be replaced with another profile if the structural strength of the trunk construction allows it. If not, the added profiles have to be welded between the existing stiffeners.

The L-profile weighs less than corresponding U-profile. L-profiles also have a broader range of choices in height and width in stock. Because of the greater height difference achieved, the fixing bolts could be shorter, thus shortening the time needed for pre-installation. The downside with using L-profiles is that since the shaft wall is rarely straight, then also the L-profile can easily be tilted to the same direction. This can be problematic when the bolts are installed into the C-profile. If the profile and the C-profile, which is directly welded onto the profile, are too much tilted the sill fixing bolts will not stand straight enough./10/

Although the U-profile weighs a bit more, it has some other benefits when compared against L-profile. The main thing in favor of the U-profile is, that it is more likely welded relatively straight, since it is welded in two places instead of just one. The U-profile is also a bit wider so it allows a larger margin for errors during welding regarding profile positioning, for example 80x45 U-profile is 15mm wider (horizontally), than 100x65 L-profile. In addition the shipyard already welds U 80x45-profiles to the trunk wall for the guide rail brackets, therefore there would not be need to stock another kind of profile./9/

After considering the pros and cons of the two possibilities, the U 80-profile is the most applicable. The shipyard uses two different stiffener heights 100 and 120mm. This means that in order to be able to use the same T-bolt length for all trunks, regardless of stiffener height, two different U-profiles must be used. U 80x45 is enough when the stiffener (HP) is 100mm. If the trunk has 120mm stiffeners U 80x80 must be used. These have the needed width regarding positioning (80mm) and they also create some elevation for the C-profile. These two U-profiles were chosen since they were the best compromise between weight and added height. The detail drawing of the construction can be seen in drawing 1 (appendix 3). The weight issue is of course always present in shipbuilding, since the yard has promised certain performance characteristics regarding ship's speed and maneuverability. For comparison the U 80x80-profile weighs 10,4 kg/m, U 80x45-profile 8,6kg/m and the L 100x65-profile weighs 8,8 kg/m. From the L-profiles this was the only one of standard stock profiles, with sufficient width of the surface where the C-profile will be welded (used C-profile for door fixing is 40mm wide). If the trunk has even one 120mm HP inside the shaft the U 80x80 profiles must be used for all decks. In case the trunk has only 100mm HP's U 80x45 is enough. /9;10/

The U 80x80 is not a standard profile in shipyards stock, but without using it another min. 25mm longer T-bolt must be also added as a variation possibility. This complicates the BOM-process and chance for errors is higher. This means more time used in sill prefabrication because of longer bolts. The use of higher U-profile depends largely on the will of the shipyard.

The weight added by this construction can be calculated by measuring the length of all needed U-profiles. In optimum situation where all the HP's in trunk are 100mm high, the added weight can be easily calculated. Project NB687 has 23 elevators with 283 decks, if two 300mm U 80x45-profiles are welded between the decks for every door, it sums up to $566\,profiles * 300mm \approx \underline{170m}$. The total added weight is then $170m * 8.6kg/m \approx \underline{1462kg}$, this is of course minimal figure considering the whole weight of the ship, but added weight non the less. From this weight can be reduced the weight difference of the shorter fixing bolts compared to the original fixing bolts and also the weight saved by possibly removing the vertical trunk stiffeners between the door openings.

The U-profile's added height to the design gives the opportunity to shorten the T-bolt. Now there are only two possibilities from which to choose for centre opening AMD-door, 300mm and 130mm long bolts (drawing 845794). Normally the door sill is max. 250mm from the trunk wall. Longer distances would create problems in installation. This means, that at present the fixing bolt is already 50mm too long even in the most extreme cases. Since the added U-profile moves the C-profile further from the wall, the bolt will be 180mm too long. The difference in U-profile height regarding T-bolt length can be compensated in design phase by placing the door sill 190mm (100mm HP) or 220mm (120mm HP) from the trunk wall. This way the same 120mm T-bolt can be used with both U-profiles.

This requires a version change to drawing 845794. The factory at Usti delivers only according to specifications in the drawing. The factory's supplier has bolt lengths from 60mm to 350mm in stock items so it would not cause any trouble in fabrication./17/

For the new fixing design the optimum T-bolt length, with minimum tolerances reserved for installation, would be 120mm. The tolerances and other measurements for the new door sill fixing design can be seen in figure 35. In case the trunk front wall would be too bent (30mm), the cabin can be shifted during alignment accordingly. If the wall is bent over 30mm the shipyard must straighten it.

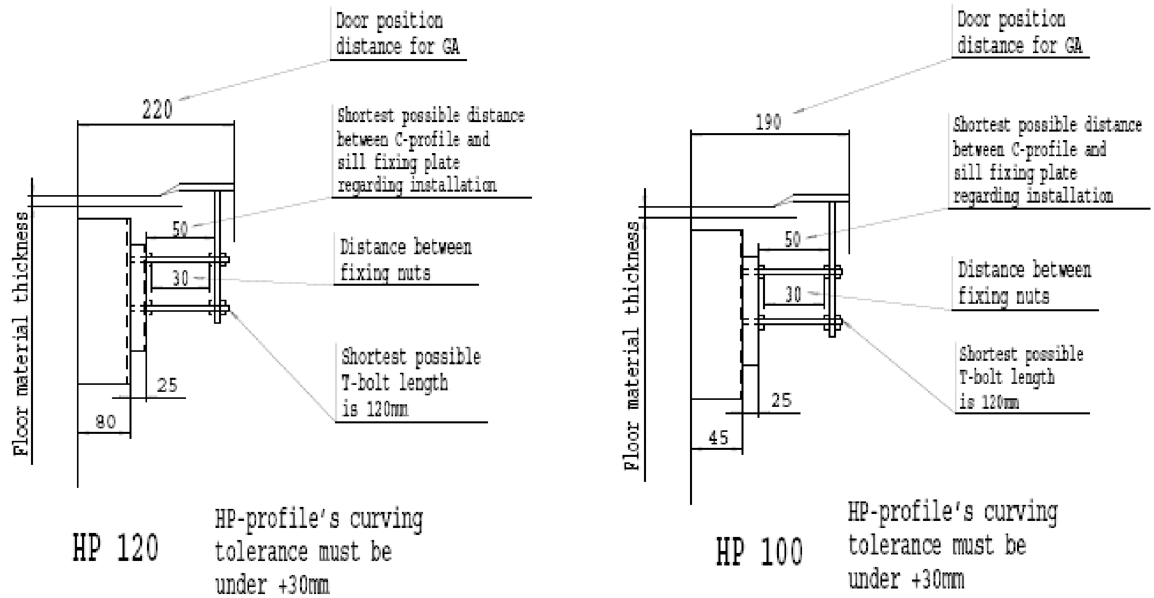

Figure 35. Measurements for new sill fixing design.

From the detail picture from drawing 1 can be seen, that with this solution there is enough space to allow slight position alteration, in addition to already existing adjustment possibilities of the door sill construction. The location of the C-profiles comes from a template, which is specified for all door widths and heights. Therefore this information can be delivered to the shipyard with the GA-drawing, so that the U-profiles can be welded to the correct position. The 300mm length of the U-profile allows possible late changes in floor thickness, or possible slight errors in placement, of approximately ±50mm. When the U-profiles are welded from the beginning of the wall building phase, the later welding of the C-profiles doesn't burn the outside trunk painting anymore. Inside trunk painting needs to be repair painted anyway due to other welding work inside the trunk. This means however to only small patches. This will save many hours of work compared to present situation. The landing door sill pre-fabrication phase can be drastically shortened. With 300mm fixing bolts this phase takes 25% of the whole door installation time, for project NB676 about 570 hours. It is a lot faster to place the three nuts to a 120mm long bolt. It will also make the final stages of the elevator installation go faster, since the trunk front wall (A) doesn't need to be painted again because of burn marks due to welding. This means also that amount of repair painting work inside the shaft will be lesser. It also means less material and work costs for the shipyard.

Since the dimensions of the template are measured from the door centerline it is of course not possible for the shipyard's welders to measure the positions exactly, because the welding has to be done before the actual door centerline is known. This is due to the fact that the elevator shaft is rarely straight and the door positions have to be measured so that it is possible to install them all in a straight line regardless of the straightness of the shaft. Therefore especially the horizontal adjustment possibility is important.

The length of the U-profile can be later changed to 200mm (equal length with C-profile), when there is practical experience from the functionality of the design and how sufficient the tolerances for installation actually are. This will lower the amount of added weight by 490kg, if U 80x45 and 590kg in case of U 80x80. If the original stiffeners can be replaced in passenger elevator trunks by the U-profile, it will reduce the weight even more.

One simple but time saving improvement would be if the whole door sill assembly, seen in figure 28, could be prefabricated already at the factory and then delivered to the site. This would simplify the beginning of the landing door installation and this task could surely be done more efficiently at the factory. This way nearly the whole pre-assembly of C-profile fixings could be eliminated. From chart 2. can be seen that since the preparation work takes 25% of the total installation time these actions would shorten it and therefore also the whole installation time. It would also require less packing material since instead of dozens of boxes or parts and blisters there could only be one crate containing the sill assemblies.

8.2.2 Upper fixings

Currently the upper fixings (railing and frame top part) for the landing door are welded directly onto the trunk wall, without delivered extensions or fixing plates as explained and can be seen in the chapter 7.2.

The new trunk structure the yard has designed for the project NB687 has new kind of intermediate wall modules inside the trunk (B, D, or both). This design can be seen in drawing 1. This new intermediate wall structure was designed so that it will be equally high between every floor so if it would be changed it would inflict changes to deck heights also to allow use of same sized assemblies. Therefore the idea of welding a U- or L-profile horizontally in place of the normal stiffener had to be abandoned, since it would have required shortening the intermediate wall to allow the wider profile to go horizontally over the intermediate wall. The shipyard was understandably not ready to make the required changes anymore at so late stage of design process./12/

With the frame top part fixings, to avoid the resulting problems, the yard has agreed to construct the vertical stiffeners besides the door opening always at the relatively same distance from the door centerline, with in the reach of the top parts fixing plates. The length of the frame top part's fixing plate is 300mm, measured from the frame up right. This allows our fitters to weld the frame top parts fixings to the side of the stiffener, instead of the trunk wall. This prevents burn marks to the paint surface. The design details of the new upper fixings can be seen in drawing 1, found in the appendix 3. This way there is no need to weld additional support plates for the fixing as it has previously been done or weld the fixing plate directly to trunk wall, as can be seen in figure 36. It also means that the additional fixing extensions and -plates are still not needed. This should be able to be applied also at other yards as long as the stiffeners are located inside the trunk. It needs only slightly increased communication between the designers. The side fixing distance should be included in the door fixing template along with the current C-profile locations.

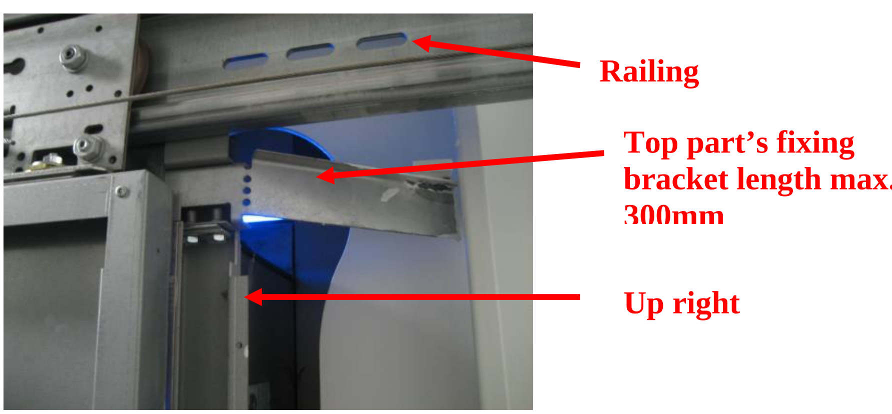

Figure 36. Door frame top part's fixing bracket.

Since welding to the bulb bar style stiffener used by the yard is only allowed in the middle section of the stiffener, as seen from figure 37, there is no danger of burning the paint of the trunk wall. The working space of the welder is off course a bit more limited in this method, but should still be sufficient. /1/

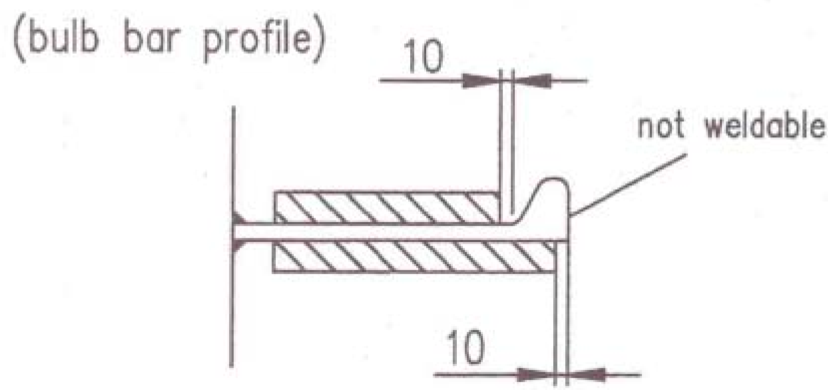

Figure 37. Weldable areas of bulb bar profile./1/

The railing fixing needs an additional plate. Currently the plate delivered for fixing, with holes for screws, is not used since it is easier and sufficient to weld a smaller steel plate which is easier to cut into appropriate length as can be seen from the figures in chapter 7.2. In the new design there is a horizontal stiffener 130mm above the door opening, on both sides of the door opening. This allows some changes so that welding directly onto the trunk wall can be avoided.

Even though in Meyer Werft most of the fixings are welded instead of using screws, the new fixing plate should also have the possibility for bolt fixing. This allows it to be used also at other sites like STX in Turku and St. Nasaire, where the fixing is done with bolts. The new fixing plate design should also have the possibility to weld it directly onto the wall if needed, since the ships steel design varies, for example in some ships the stiffeners can be located outside the trunk. In this design type there are no issues with the trunk wall painting, since the shipyard has to construct a wall on the corridor side to cover the stiffeners and therefore the wall is not painted.

The design of the fixing plate can be seen in drawing 2, which can be found in appendix 4. From the drawing can be seen the measurements needed for the plate. The measurements are done so that moderate alterations in stiffener's vertical location will not prevent the use of the bracket. There are also horizontal long holes for bolt fixing allowing adjustment. The railing has vertical long holes so when the parts are fastened together it is possible to adjust the fixing in both vertical and horizontal directions. The horizontal depth can also be adjusted by either cutting of a piece from the plate if the railing would be situated too far from the wall, or to the other direction by moving the plate forward if the stiffener is long enough. In extreme cases, if for example stiffeners are located outside, the bracket can also be welded directly onto the trunk wall. From the second page of appendix 4 can be seen the idea of how the fixing plate should be welded onto the horizontal stiffener.

Plate's thickness of 4mm was chosen because then it can be easily manufactured; cut with laser or abrasive water jet. The brackets edges should be made as straight as possible, so that there are no difficulties in positioning the bracket level on top of the stiffener. Otherwise it is difficult to install the door railing straight. The landing door will not function properly, if the railing is too inclined. Three horizontal holes allow greater variation, than the two holes design of the former bracket, in vertical direction. The bracket will not, under normal circumstances, have to endure heavy loads, since the railing is also fixed to the frame top part, so material strength is not an issue. Normal S235 construction steel has sufficient material qualities. Since the shipyard has promised to build the ship to fulfill certain weight norms the total weight of the various components installed into a ship must be as low as possible. The bracket weighs less than 1kg, so this added weight doesn't cause issues.

In case the horizontal stiffeners position is lower the L-bracket can also be welded the L pointing upwards. Then can be achieved enough elevation so that the bolt holes will match. In case the plate has to be moved radically forward, it is also possible to weld support plates if the welding seam would be too short.

There are of course limitations for the stiffener location, mainly concerning unobstructed function of the door opening mechanism. If the stiffener is located too low and comes too far from the trunk wall it can hit the railing. The allowed stiffener height depends of course also from the door sill's horizontal distance from the trunk wall. The stiffeners vertical position limitations were measured by using a cardboard template of the new L-bracket, since schedule didn't allow fabricating a real example of steel. This template was also used to test the functionality of the hole placement and if the dimension were adequate in the allowed variation zone of the stiffener position. These limitations can be found in drawing 1. With the help of these measurements it should be possible to clarify to the shipyard the area where the stiffener positions would be optimal considering fixings.

It should be clarified to the shipyard that the correct stiffener positioning will make the installation go along faster and save a lot of painting costs (for material and work). Therefore there should not be any difficulties in getting the shipyards acceptance, after all this lowers the work costs. This works of course only if the alterations don't contradict with the trunk material strength calculations.

The welding details on page 2 of drawing 2 are done according to the rules stated in MWS 0.11-0.12. The document has also rules for welding onto different types of stiffeners (flat-, L-shaped, T-shaped). For these however apply the same principles as for the bulb bar- profile as can be seen from figure 38. The document is from Meyer Werft but all shipyards have similar rules considering welding on stiffeners, so this document can be used as a reference. /1/

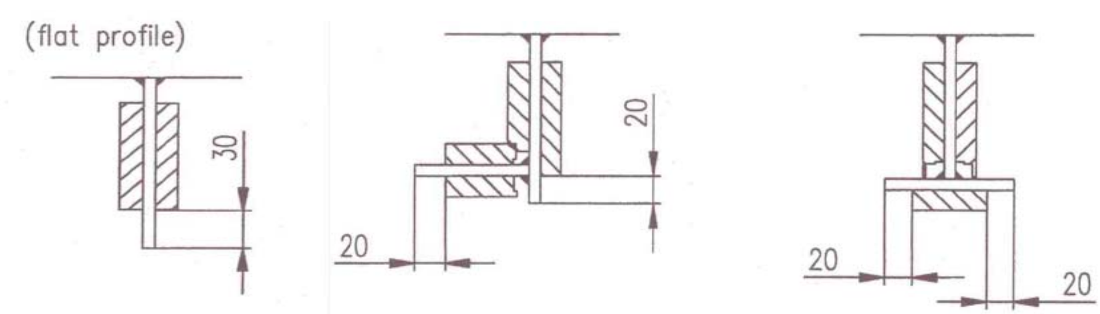

Figure 38. Examples of other stiffener type's weldable areas./1/

8.3 Material issues

Issues with door frame top part related to door emergency opening mechanism are only a matter of better instructions (drawing) and training. The return spring is simple to install and therefore the only issue is with the person assembling the return spring. The drawing 731435 should be revised so that it is shows the correct way the spring must be installed. After the drawing is revised, a two hour training session should be enough, to achieve desired quality.

The factory in Usti nad Labem has agreed to change the C-profile into non Zink coated version after the existing stock of old Zink coated C-profiles has run out. This is not ideal but it will fix the problems regarding the welding issues once the new profiles are in delivery schedule. Issue with landing door counterweight wires is under investigation. Samples of broken wires were sent to Usti for analysis and as a result a new batch was sent were the clamp at the end of the rope is pressed tighter. The improvement has yet to be tested in practice if it solves the issue. /16;18/

The reason for problems with bent landing door panels has been found and the quality control department in Usti is working to solve the issue. Samples of landing doors with broken spot welding were sent to Usti. According to investigations the tip of the welding electrode was too worn out. A procedure has been created to change the welding electrode regularly to avoid similar problems in future. The results of these actions have to be controlled from the next shipment of landing doors. Increased quality control will be performed for the next shipments from Usti by inspecting the landing door panels and the fabrication principles at the factory, before they are sent to the site. If these meet the quality requirements the deliveries can proceed./16;18/

9. Summary

The aim of this thesis project was to create a general installation instruction for marine elevators, including both Minispace and Monospace solutions, and to find the problems related to the landing door installation process. This thesis also introduced some possible solutions for these problems. The aim of finding these problems was to inform the responsible people where they should focus their attention in order to improve the quality and speed of the landing door installation process. The general installation instruction and the drawings related to new door fixing solutions are confidential and can be found only at the KONE Elevators Ltd.'s book version.

This thesis project has met the goals set for it, since the general installation instruction was created and the biggest time consuming problems of the installation process have been identified. The general installation instruction will probably be modified later to cover all the slightly different installation methods at shipyards located in France and Finland, which could not be included yet due to lack of time. The thesis can be used to locate and fix the issues which affect the most to the net time needed to complete the installation. The general installation instruction can also be used as a base for a more detailed installation manual, where the installation methods are introduced in detail with description of the used template tools. The improvements suggested in this thesis for landing door installation and logistical issues, will be tested in the next project NB687.

List of references

Literary references

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Company's internal sources

/2/ KONE corporation database, KONE profile 2009, powerpoint presentation

/3/ KONE corporation database, KONE Marine general presentation, powerpoint presentation

/4/ KONE Minispace brochure

/5/ KONE Monospace brochure

/6/ KONE Installation instruction, AM-03.12.042-MAR, revision A

/7/ KONE Installation instruction, AM-03.12.066, revision H

Websites

/8/ www.meyerwerft.com, referred to 3.4.2009

/9/ www.arcelormittal.com, production program cold-formed steel open profiles , referred to 19.5.2009

/10/ www.arcelormittal.com, product information for equal and unequal angles, referred to 19.5.2009

Interviews and meetings

/11/ Interview with: Site manager Erik Pedersen, at STX Europe, Turku 8.4.2009

/12/ Meeting regarding project NB687, present: Tommi Heikkilä, Udo Salem, Andreas Schnieders and Gerhard Wahrheit, at Meyer Werft Papenburg 17.3.2009

/13/ Interview with: Ronny Trost, at Meyer Werft, Papenburg 24.4.2009

/14/ Interview with: Ingo Jeschke, at Meyer Werft, Papenburg 29.4.2009

/15/ Interview with: Dirk Salem and Dietmar Beets, at Meyer Werft, Papenburg 27.3.2009

/16/ Meeting regarding landing door problems, present: Tommi Heikkilä, Matti Mustonen, Jyrki Nummisalo and Harri Anttila, at Hyvinkää/ Papenburg 2.4.2009

/17/ Interview with: Petr Cafourek at Papenburg/ Usti nad Labem 25.5.2009

/18/ Interview with: Jörn Wienholz-Buβ at Papenburg 3.6.2009

Erklärung

Ich erkläre, dass ich die vorliegende Arbeit selbstständig und nur unter Vervendung der angegebenen Literatur und Hilfsmittel angefertigt habe.

Ort, Datum Unterschrift

19.6.2009 Hannover

Appendices